



考察紅樹林生態系統 Study of Mangrove Ecosystem

姓名 Name _____ 組別 Group _____ 日期 Date: _____

學習目標 Learning goals:

完成課程後，學生應能 After the course, students should be able to:

- 辨認在紅樹林常見的生物，並將其分類；
Classify and identify living organisms commonly found in a local mangrove habitat;
- 觀察生物如何適應環境 Observe how living organisms adapt to the environment;
- 識別生態系統中生物與生物之間的關係
Identify interrelationships between living organisms in an ecosystem;
- 在紅樹林量度和記錄非生物因素 Record and measure abiotic factors in a mangrove ecosystem;
- 使用簡單取樣工具 Use simple sampling tools;
- 在實驗室執行簡單水質測試 Do simple chemical analysis of water sample in the laboratory;
- 組織和分析數據作簡報之用 Analyze and organize data for presentation;
- 與他人合作進行科學探究 Cooperate with others and work together in a scientific investigation;
- 欣賞自然，尊重生物 Appreciate nature and respect living things.

程序 Schedule

9:00 - 09:50	簡介 Briefing
10:00 - 13:00	考察 Field work
13:00 - 14:00	午膳 Lunch
14:00 - 15:00	實驗工作 Laboratory work
15:00 - 15:30	資料整理 Data processing
15:30 - 16:15	分組匯報 Group presentation
16:15 - 16:30	討論及總結 Discussion & summary

儀器和工具 Equipment and tools

1	寫字夾板 (x1) Clipboard	10	膠整理盤 (x1) Plastic tray
2	光強度計 (x1) Light meter	11	小鏟 (x2) Trowel
3	風速計 (x1) Anemometer	12	樣方 0.5 x 0.5米 (x1) Quadrat
4	電子溫濕計 (x1) Digital themohygrometer	13	手套 (x2 對) Gloves
5	土壤溫度計 (x1) Soil thermometer	14	膠整理盤 (x1) Plastic sorting tray
6	金屬篩 (x1) Metal sieve	15	取水樣瓶 (x1) Water sampling bottle
7	鑷子 (x2) Forceps	16	圖鑑 (x1 set) Pictorial Guide
8	水桶 (x2) Bucket	17	平板電腦 (x1) Tablet computer
9	膠袋 (x1) Plastic bag		

衣著 Clothing:

- 穿著長袖上衣和長褲能更有效防止蚊蟲叮咬，亦可減低被太陽曬傷的機會，不應穿著短褲。 Long-sleeved shirt and trousers for better protection against mosquito and insect bites, as well as preventing sunburn. Shorts are not recommended.
- 不應穿著拖鞋或涼鞋，而應穿著運動布鞋，以減低腳部受傷的機會。 A pair of plimsolls for preventing injuries. Slippers and sandals are not recommended.

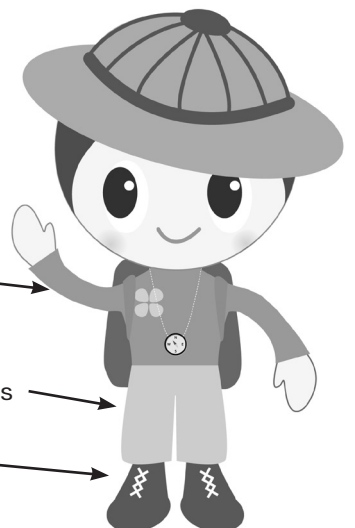
安全 Safety:

- 避免踏進泥土過度鬆軟的區域。蠔殼可致嚴重割傷，必須小心。
Avoid stepping onto slimy areas. Beware of oyster shells which could cause serious wound.
- 留意潮水，當潮水漲至膝蓋時，從速離開。
Leave the area once the knees were submerged by the incoming tide.

長袖上衣
Long-sleeved shirt

長褲 Trousers

運動布鞋
Plimsolls



1. 記錄環境因素 Recording environmental factors

- a. 記下近日的降雨、雲量、氣溫等天氣資料。Note down recent weather conditions such as rainfall, cloudiness and air temperature.
- b. 描述紅樹林周邊的環境，包括附近生境類型、土地用途、村落位置和各種可能的人為干擾等，並繪製一幅簡圖，以顯示相關資料。Describe the physical environment near the mangrove habitat, such as nearby habitat types, land use, location of village and possible human impacts. Draw a sketch map to show relevant information.

2. 取水樣 Water sampling

利用取水樣瓶在最接近考察地方的位置取海水樣本，帶返實驗室作化學分析。Use a water sampling bottle to collect water sample at the location closer to your study area. Bring the water sample to the laboratory for further chemical analysis.

3. 觀察土壤 Observing soil

找一處有軟泥的地點，用小鏟垂直向下插入，並掘出土壤，細心觀察各層泥土的顏色和性質。Select an area with soft substratum. Dig vertically into the soil by a trowel and notice the nature and colour of the soil layers from top to bottom.

4. 主動搜尋動物 Active searching for animals

透過仔細觀察，搜尋生活在不同小生境的動物——沙泥表面、石塊表面、石塊底下、紅樹根部、紅樹葉和枝幹上等。留意動物的各種適應特徵。用攝影或攝錄，記錄各種動物的外貌和行為特徵。By careful observation, search for animals living in different micro-habitats - on sand or mud surface, on rock surface, under rock, on mangrove root, on mangrove leaf surface or branch. Pay attention to various adaptive features equipped by the animals. Use photography and videography to record the external features and behaviour of the animals species.

動物名稱和分類 Animal name and classification	微生境 † Micro-habitat	抗熱抗旱 § Preventing desiccation & overheat	攝食模式 # Mode of feeding

† 1. 沙泥表面 On sand or mud surface 2. 沙泥裡 In the sand or mud 3. 石塊表面 On rock surface 4. 石塊底下 Under rock 5. 紅樹根部 On mangrove root 6. 紅樹葉上 On mangrove leaf 7. 紅樹枝幹上 On mangrove branch

§ 1. 厚殼和厝 Thick shell and operculum 2. 外殼中空 Hollow shell 3. 棲身於紅樹下 Hide under mangrove canopy 4. 藏身於石塊下 Hide under rocks 5. 藏身於泥土之中 Burrow into the soil

1. 濾食性 Filter feeding 2. 沉積食性 Deposit feeding 3. 吞食性 Bulk feeding
 A. 肉食性 Carnivorous B. 植食性 Herbivorous C. 腐食性 Detritivorous



5. 樣帶動物調查 Belt transect survey for animals

- i. 由下潮帶拉一條三十米卷尺到紅樹林，在每隔十米距離擺放一個 0.5x0.5 米的樣方。先仔細找尋並撿起泥面／石面的動物，放在膠整理盤內；如樣方內有碎石，可揭起石塊，查看藏於石塊底下的動物；然後利用小鏟，小心掘出沙泥裡的動物，辨認和點算樣方內找到仍然活著的動物。
- ii. 記錄樣方放置位置的非生物因子，每項參數量度三次，取其平均值。
- iii. 完成第一個樣方後，重覆上述工作，直至一共四個樣方的數據收集。

- i. Lay 30m measuring tape from upper shore to the seaside, place 0.5 m X 0.5 m quadrat at every 10m interval. Pick up the animals found on the rock surface within the quadrat, identify and count in the tray. If there are stones within the quadrat, lift the stones to look for animals hiding beneath. Use a trowel, carefully dig out animals in the soil, identify and count every living animals.
- ii. Record the abiotic factors of the area sampled. For each parameter, take three measurements and get the mean.
- iii. After complete the first quadrat, repeat the above procedure and finish the data collection in all four quadrats.

動物名稱 Animal name	抵抗捕食者方式 # Anti-predation methods	個體數目 No. of individuals			
		樣方一 Quadrat 1	樣方二 Quadrat 2	樣方三 Quadrat 3	樣方四 Quadrat 4

- # 1. 具硬殼 Bearing hard shell 2. 偽裝 Camouflage 3. 警戒色 Warning colour 4. 反應迅速如逃跑 Quick reaction e.g. fast run
5. 沒有反應如裝死 No reaction e.g. playing dead 6. 附著於硬基質上 Firmly attached to hard substratum 7. 鑽入基質 Drill in substratum

	氣溫 (°C) Air temperature	相對濕度(%) Relative humidity	光強度(lux) Light intensity	風速(m/s) Wind speed
樣方一 Quadrat 1				
樣方二 Quadrat 2				
樣方三 Quadrat 3				
樣方四 Quadrat 4				

6. 記錄植物 Recording plants

- i. 辨認3種真紅樹品種 (通常生長在較接近海水位置)和2種類紅樹品種 (通常生長在較近陸地位置)。Identify 3 species of true mangrove plants (usually growing closer to the sea) and 2 species of associated mangrove plants (usually growing at the back shore far away from the sea).
- ii. 細心觀察並記錄每種紅樹和類紅樹的適應特徵。Observe carefully and record the adaptive features of each mangrove and associated mangrove species.

植物名稱 Plant name	有助紅樹於鬆軟基質上 固定的根部特徵 Root features enhancing better anchorage on unstable substratum	有助紅樹於缺氧基質 進行氣體交換的根部 特徵 Root features enhancing better gaseous exchange in water-logged soil:	有助於紅樹調節植物組織 內含鹽量和水份的葉 部特徵 Leaf features related to regulation of water potential and salt content in plant tissue	有助紅樹減低海潮對種子 散播的衝擊的生殖系統 特徵 Modifications of reproductive system to minimize impact of tide on seed dispersal
<input type="radio"/> 真紅樹 True mangrove <input type="radio"/> 類紅樹 Associated mangrove				
<input type="radio"/> 真紅樹 True mangrove <input type="radio"/> 類紅樹 Associated mangrove				
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<input type="radio"/> 真紅樹 True mangrove <input type="radio"/> 類紅樹 Associated mangrove				

實驗室工作 Laboratory work

7. 水質測試 Water test

- i. 用折光儀量度海水樣本的鹽度。Use an refractometer to measure salinity of the water sample.
- ii. 以過濾法量度海水樣本的總懸浮物。Use filtration method to measure total suspended solids of the water sample.

8. 觀察紅樹葉結構 (延伸活動) Observation on structure of mangrove leaves (Extended activity)

將紅樹和類紅樹的葉橫向切片,置於顯微鏡底下觀察。Do cross sections of the mangrove leaves and examine under the microscope.